Remarks

Applicants appreciate the Examiner's acceptance of the Wehrli Declaration and withdrawal of the Takahashi reference as prior art 35 U.S.C. 102(a), and the withdrawal of the claim rejections under 35 U.S.C. 112, 1st and 2nd paragraphs. Applicants have carefully considered the Examiner's Action with regard to this Application, and respectfully request reconsideration of the rejections in view of the foregoing amendments, and the following remarks.

Claims 1-28 remain pending in the present application. New claims 31-34 are added. The amendments are made based upon support in Applicants' specification. The phrase "computer processed" in claims 1 and 17 is supported at least by the use of the term "computed" rather than "calculated" throughout the specification, see, *e.g.*, paragraphs [0108]-[0109]. In fact, claims 1 and 17 each define the method as a "computational method" in the preamble and state the steps in terms of what is "computed" or "computing," which clearly requires a computer process. See, *e.g.*, paragraph [0039] ("the Algorithm section of the specification describes a dynamic programming-based algorithm for computing FDT of digital objects") Example 2, *e.g.*, paragraph [0119] refers specifically to "high-resolution, micro-computed tomography;" Example 3, *e.g.*, paragraph [0122] refers specifically to processing, meaning computer processing ("image sets were processed to generate BVF maps" and "at each point p, the BVF value was computed." See also paragraphs [0067], [0100], [0104], [0108] and [0120] describing the computations used in the claimed invention.

The computer processing in the specification is further supported at least in the description of the processing of the iterative algorithm beginning at paragraph [0081] ("a dynamic programming-based algorithm is presented in the invention for computing FDT of fuzzy digital objects." The reference to "do-loop" in paragraph [0084] is specific to computer processing.

Only the dependency of claims 25-28 is changed to re-focus the claims to expressly encompass the method of claim 1, which is the subject of the present invention, rather than a physical component. New claims 31-34 find the same support and further define claim 17.

New Figure 19 is added and support is provided in the following section.

The specification is amended to insert the addition of Fig. 19 into the Description of the

Drawings, and also to correct a typographical error in paragraph [0145] since quite clearly there is no Example 7 in this specification, meaning there is none to reference.

No new matter is added.

Response to the Drawings Objection under 37 C.F.R. §1.83(a)

The Examiner has objected to Applicants' drawings under 37 C.F.R. 1.83(a), stating that "the drawings must show every feature of the invention specified in the claims, and further states that "corrected drawing sheets in compliance with 37 C.F.R. 1.121(d) are required in reply to the Office Action to avoid abandonment of the application." Thus, Applicants are placed in an untenable position because the Examiner's Objection is either misplaced or incorrect, yet the Examiner has permitted no discussion regarding this Objection, stating that unless Applicants provide the drawing as required, the application will be automatically "abandoned," and that the "Objection to the drawings will not be held in abeyance."

The Examiner is incomplete in his statement of why the drawing is required. The quoted Patent Rule controlling patent drawings is set forth in 37 C.F.R. §1.83 in two parts – not the statement quoted by the Examiner alone. 37 C.F.R. §1.83(a) reads:

> Content of drawing
> (a) The drawing in a nonprovisional application must show every feature of the invention specified in the claims. *However, conventional features disclosed in the description and claims, where their detailed illustration is not essential for a proper understanding of the invention, should be illustrated in the drawing* in the form of a graphical drawing symbol or a labeled representation (e.g., a labeled rectangular box).

Thus, the intent of the Rule is incomplete - without adding the second statement - shown in underlined italics added by Applicants. Specifically, the assumption that drawing are required in a patent is incorrect, unless read with the stated understanding that detailed illustrations are not needed when the features are described in the words of the specification. Rather than using drawings to try to show the computations made to arrive at Applicants' method claimed in the invention, Applicants have provided the equations, theorems and proofs used in the calculations used to transform the original images to the resulting higher resolution images, as would be understood by one skilled in the relevant art. The Figures (drawings) provided with the application show to such an individual of ordinary skill, examples of what is meant by a fuzzy subset and the effect of applying the FDT on a fuzzy object, such as use of the FDT-based thickness computation method. These things are best shown by the Figures provided since

comparisons cannot always be clearly understood in words alone. But the flow chart which the Examiner appears to want added to the application, has no place in Applicants' presently claimed method. Because the steps of Applicants' claims as stated in words are, in fact, "*not essential for a proper understanding of the invention*," and as a result are not required under the Patent Rules. See, MPEP 608.02(d) Complete Illustration in Drawings.

This is more clearly stated in 37 C.F.R. §1.81, which reads:

> § 1.81 Drawings required in patent application.
>
> (a) The applicant for a patent is required to furnish a drawing of his or her invention *where necessary for the understanding of the subject matter sought to be patented*; this drawing, or a high quality copy thereof, must be filed with the application. Since corrections are the responsibility of the applicant, the original drawing(s) should be retained by the applicant for any necessary future correction.
>
> (b) Drawings may include illustrations which facilitate an understanding of the invention (for example, flowsheets in cases of processes, and diagrammatic views).
>
> (c) Whenever the nature of the subject matter sought to be patented admits of illustration by a drawing without its being necessary for the understanding of the subject matter and the applicant has not furnished such a drawing, the examiner will require its submission within a time period of not less than two months from the date of the sending of a notice thereof.

Applicants have made no reference under 37 C.F.R. §1.81(c) in the Application to the drawing which the Examiner claims is missing from the Application. Therefore under section (a) such drawing are required in a patent application ONLY *where necessary for the understanding of the subject matter sought to be patented*. Adding a flow chart to reiterate the steps in claim 1 are not necessary for understanding Applicants' invention.

The quoted section of 37 C.F.R. §1.81(a) is repeated in the actual law regarding drawings in a patent are set forth in 35 U.S.C. §113

> Drawings.
> The applicant shall furnish a drawing *where necessary for the understanding of the subject matter sought to be patented*. When the nature of such subject matter admits of illustration by a drawing and the applicant has not furnished such a drawing, the Director may require its submission within a time period of not less than two months from the sending of a notice thereof. Drawings submitted after the filing date of the application may not be used (i) to overcome any insufficiency of the specification due to lack of an enabling disclosure or otherwise inadequate disclosure therein, or (ii) to supplement the original disclosure thereof for the purpose of interpretation of the scope of any claim.

Thus, Congress has said that drawings are *optional* unless required for understanding the invention. It would be improper for the PTO to freely establish its own rules for patentability,

and they have not done so, as the Rule reiterates the law. The present question, therefore, lies in the interpretation of the law. To resolve that question, Applicants again turn to the MPEP §601.01(f) explaining 35 U.S.C. §113 by stating:

> It has been USPTO practice to treat an application that contains at least one process or method claim as an application for which a drawing is not necessary for an understanding of the invention under 35 U.S.C. 113 (first sentence).

Applicants' invention is indeed a method, all claims are drawn to a method, and the MPEP is very clear that when the application contains *method* claims, drawings are NOT necessary. The application as originally accepted, was not subject to a "Notice of Incomplete Application" for a failure to provide drawings necessary to an understanding of the invention. Thus, the application was found to be complete at the time it was accepted, and it is unfair to Applicants to make a determination six (6) years after the application was filed and following many rounds of examination communications, for the Examiner to now say that a new drawing is necessary – contrary to laws determined by Congress and contrary to the Patent Rules saying that patent applications drawn to "method claims" do not require drawings.

More troubling, however, is the fact that the Examiner has cautioned Applicants that if the new drawing is not provided as required – that the application will be ABANDONED. Thus, Applicants are offered no alternative, other than either to provide what they believe to be an unnecessary drawing in the Application, or to file and prosecute a petition to have such a decision by the Examiner overturned.

For this reason, and for this reason alone, although Applicants argue that the Examiner's requirement is misplaced and improper, and that no such drawing is necessary in Applicants' invention, Applicants have provided a flowchart as new FIG. 19, and amended the accompanying text of the specification. The text found in new FIG 19 is exactly as quoted by the Examiner in the current Action. The chart adds no new matter, because the text used in the flowchart are quoted from claim 1 as originally filed, which is, therefore, encompassed within the original specification. See, MPEP 2163, section I, end of second paragraph ("It is now well accepted that a satisfactory description may be in the claims or any other portion of the originally filed specification."). Thus, the content of the new Figure finds exact support in the claims as originally filed. The final step of the Figure is supported by the depicted plots at Figs. 10, 12, 18 and the descriptions at paragraphs [0030], [0032], [0038], [0128], [0130], [0133] - [0135], [0140], [0146]. A reconstructed or revised image is shown at Fig, 16, described at paragraph

[0036] and in Examples 1-2, see, for example paragraph [0116], [0118]-[0120] and Example 3.

As claimed originally, Step (a) of claim 1, obtaining an image of the targeted object is further supported, at least by Experiment 4, paragraph [0141] and by the description of the use of magnetic resonance imaging or computed tomographic image of the targeted object at paragraph [0003] or in the Examples, *e.g.*, paragraphs [0112] or [0117].

Step (b) of claim 1, finding a plurality of points in the image to generate a fuzzy subset and compute a fuzzy distance transform (FDT) of the fuzzy subset, is supported, at least, by the detailed description at paragraphs [0006] and [0007] of a fuzzy distance transform, and the reference to the plurality of points at, *e.g.*, paragraph [0013]. The generation of the "fuzzy subset" is defined and referenced throughout the application, but see paragraphs [0013] and [0015] and in FIG 1, and in the section entitled Theory, *e.g.*, paragraphs [0044], [0045], [0049], [0055], [0058], [0059] and [0067]. The section entitled "Algorithms" at paragraph [0078] begin at paragraph [0079] to present "an algorithm embodiment is presented for "computing the FDT of digital objects."

Step (c) of pending claim 1, although not present in the original claim 1 as filed, reads "compiling a computer processed plot or revised image based upon the computed FDT." This step now reiterated on the new FIG. 19 flowchart is supported, at least, by paragraphs [0030] (FIG. 10), [0032] (FIG. 12), and [0038] (FIG. 18), and in the paragraphs relating to those Figures. In practice, Experiment 1 describes the computation (compilation) process at paragraph [0128].

Accordingly, the new FIG. 19 flowchart, while not believed to be necessary for understanding the present invention, is added as required by the Examiner, using the words suggested by the Examiner, and as fully supported by the specification. As shown, the additional Figure enters no new matter into the application and required no additional examination, since each word is found in the previously examined claims. Consequently, Applicants respectfully ask that the required addition of a new drawing to elucidate the stated steps in Applicants' claims 1 and 17 be reconsidered and reversed by the Examiner. Or in light of Applicants' addition of new FIG. 19, Applicants ask that the Examiner's Objection be withdrawn and the claims reconsidered and held to be allowable. In the event that new FIG. 19 is not exactly what the Examiner requires, Applicants ask that the Examiner's statement that the Application "will be abandoned" be withdrawn, given that Applicants have made a good faith effort to comply with

the Examiner's requirement to the best of their ability, even though it is believed such an addition is unnecessary to the patentability of the invention.

Applicants have further added a description of Figure 19 into the specification, but it can be removed if the Examiner agrees with Applicants that the addition of Fig. 19 is superfluous and completely unnecessary.

Response to the Rejection under 35 U.S.C. §101

The Examiner has rejected claims 1-16 and 17-24 under 35 U.S.C. §101 as being directed to non-statutory subject matter. However, in light of the Examiner's comments, Applicants have amended the claims to clearly state the electronic generation of the lower resolution images (see paragraph [0039]), and of the computer processing to generate the revised high resolution plot or image based upon the fuzzy distance transform (FDT), which is the stated utility of the invention. Support is provided above. Thus, the rejection is, therefore moot. Applicants respectfully ask that the rejection be reconsidered and withdrawn.

Response to the Rejection under 35 U.S.C. §112, first paragraph.

The Examiner has rejected claim 25 and claims 26-28 dependent thereon under 35 U.S.C. §112, first paragraph as failing to comply with the written description requirement and introducing new matter. However, in light of Applicants' amendment, making claim 25 dependent on and further defining the claimed method of claim 1, thereby removing al reference to "medium" or "means, the rejection is, therefore moot, and Applicants respectfully ask that it be withdrawn and the claims found to be allowable.

Response to the Rejection under 35 U.S.C. §102(a).

Although the Examiner has removed the prior rejection over Takahashi, a new rejection is made of claim 1 under 35 U.S.C. §102(a) as anticipated over Borgefors, *IEEE*, pages 180-183 (August 2002), previously defined by the Examiner in the Office Action mailed on 6/9/08 as "made of record but not relied on." Nevertheless, the Borgefors reference is not a proper prior art reference in that it was published after Applicants' date of invention, and also it fails to teach Applicants' invention.

Section 102(a) states that "A person shall be entitled to a patent unless - (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, *before the invention thereof by the applicant for a patent.* As noted in

the emphasis added to the stated law, a reference is effective prior art only if the publication preceded Applicants' invention. The present application, U.S. Patent Appl. 10/ 728,496, was filed December 5, 2003, claiming the effective filing date, December 5, 2002, of U.S. Provisional Application No. 60/431,129. However, Applicants' invention preceded those stated dates as is clearly set forth in the Wehrli Declaration, which the Examiner expressly indicated was accepted into the present record and which was the basis for the withdrawal of the rejection over Takahashi. Dr. Wehrli's Declaration, whether identified as under 37 C.F.R. 1.131 or 1.132, shows that Applicants' invention preceded the cited Takahashi paper, which was published in May 2002. Consequently, Applicants' invention necessarily also preceded the subsequently-published Borgefors' paper, dated August 2002. See, Paragraph 5 of the Wehrli Declaration. Thus, neither cited reference is proper prior art against Applicants' invention for §102(a).

Moreover, as further noted in the Wehrli Declaration at paragraph 8, following May 2002, Applicants diligently reduced their invention to practice, establishing that at least between August 2002 and the December 5, 2002 filing of provisional application 60/431,129, the invention was diligently reduced to practice. Because there is no evidence to the contrary, a separate Declaration should not be needed to establish the date of Applicants' invention prior to August 2002, since the record already establishes that the date of invention was prior to the Takahashi publication date in May 2002, regardless of why the Wehrli Declaration was originally submitted into the record. However, should yet another Declaration be required by the Examiner to expressly establish Applicants' date of invention prior to August 2002, Applicants will certainly comply and can provide such a Declaration upon request.

Nevertheless, even if the Borgefors reference were proper prior art to Applicants' invention, which it is not, it fails to anticipate Applicants' invention because the subject matter of taught by Borgefors is distinguished from that of Applicants' invention. As indicated in the Abstract of the Borgefors reference, cited by the Examiner, segmentation is a difficult task in image analysis, and it is approached by different groups in different ways. Borgefors proposed a solution to computing distance transforms in images with fuzzy object ***borders***. See, Borgefors at page 180, column 2, under the heading "Fuzzy border distance transforms," the Borgefors' method begins with the creation of a "*binary* image." However, for example, at paragraph [0080] of the specification, Applicants' explain why binary imaging is inappropriate for the methods of the presently claimed invention. Thus, the Borgefors' method is different from a

standard object-based, distance transform in the initialization step, which takes only the fuzziness of the *border* into account, and is thus referred to as a "fuzzy border distance transform." Consequently, Borgefors' method is also different from the methods of Applicants' invention.

Approaches to image delineation may be broadly classified into two groups: 1) boundary- or border-based; and 2) object or region-based. Border-based methods, such as Borgefors, produce a delineation of the object boundaries in the image, whereas object-based methods, such as the present invention, generate delineations in the form of the region occupied by the object with regard to multiple objects in the image. Note that Applicants' claim 1 is specific to the volumetric region of an object, specifically a fuzzy object-based distance transform method – not a fuzzy border distance transform (Claim 1 reads: "A fuzzy distance transform-based computational method for analyzing digital images defining a volumetric region of an object. .").

Each of these groups may be further divided into subgroups—hard and fuzzy—depending on whether the defined regions/boundaries are described by hard or fuzzy sets. Consequently, both Applicants and Borgefors may relate to fuzzy sets, yet the methods for proving the enhanced image, and thus the revised image itself, are different because Borgefors' method is specific to the border distance transform. Applicants' method is specific to, and expressly defines "defining a *volumetric region* of an *object*." See claim 1. Thus, the methods are different, meaning that the results are different, and cannot be readily compared. Nor could one method define the other, since the principles for analyzing the image are different.

As indicated in, for example, the Sintorn Doctoral Thesis of 2005 at Upsula University in the Borgefors' laboratory (see, http: diss-epsilon.slu.se/archive/00000781/01/thesis_final.pdf), the object-based distance transform (DT) methods of Saha, and the border-based methods, such as Borgefors', are mixed modalities that cannot be compared, although they are each trying to solve how to calculate grey-level images:

> Attempts have been made to calculate DTs on grey-level images, and thereby incorporate underlying grey-level information into the DT, (Rosin and West, 1995; Ikonen and Pekka, 2005; Saha et al., 2002; Svensson and Borgefors, 2002b). However, it is difficult to weigh together the importance of the distance and intensity information. Despite the problem of mixing modalities, grey-weighted DTs have shown to be useful in certain applications.

Note that the Sintorn thesis is only cited by example of a review publication explaining the state of the art beginning in 2002, but it is neither prior art to Applicants' invention, nor is it cited under for Form 1449 purposes. It can be viewed on-line, but it is not provided herewith since it

is merely representative. It is used only as general guidance to show that others have tried to compare Dr. Saha's work, a co-inventor hereto, and Borgefors, and found that their techniques are different modalities that cannot be adequately compared. Sintorn is not a cited reference.

As described in Applicants' application at paragraph [0080], Borgefors used a raster scan approach that effectively computes regular DT for binary images using only two scans. In *border-based methods* the algorithm considers fuzziness only at the time of binary initialization. Binary imaging measures the shortest path from a point to the background (the complement of the binary object), which is always a straight-line segment (in a digital sense). However, because such reasoning is not true for *fuzzy digital objects of Applicants' invention* (see FIG. 8),wherein the algorithm considers fuzziness during iterative propagation, a linear (binary) or raster scan based approach is inappropriate in computing FDT, as utilized in Applicants' invention. See claim 1.

Thus, Borgefors and Applicants use "different modalities," which cannot be effectively compared. A DT can be calculated for 2D and 3D images, as well as for images of higher dimensionality, by propagating local distances in two passes over the image. In the Borgefors' border-based method, the elements in the object are set to infinity, and the elements in the background to 0, prior to running the two passes. During the first, forward pass, the image is processed from left to right and from top to bottom and in 3D, also from front to back. Some authors use non-square or non-cubic grid models. Nevertheless the idea of representing a 3D shape by a centralized curve, to simplify analysis, is transferred to the case of grey-level values inside the object, as reported by Borgefors. Consequently, instead of finding the most central curve, the algorithm searches for a curve following the maximum intensity.

In marked contrast, Applicants object-based FDT, as identified in a step of Applicants' claimed method, is defined by Applicants, *e.g.,* at paragraphs [0007], [0063]-[0070], [0073]-[0074] and [0098], and the Borgefors' method, as still used in the 2002 paper, is clearly and explicitly distinguished from Applicants' method in paragraph [0080].

While the cited Borgefors reference has developed a "fuzzy *border* distance transform" for use in the widely studied concept of skeletonization (see Applicants' paragraph [0098]), the cited manuscript fails to teach, or even reference Applicants' method for calculating an *object based* fuzzy distance transform. See, claim 1, "a fuzzy distance transform-based computational method for analyzing digital images defining a *volumetric region of an object* from an image

comprising: (a) obtaining an image of the targeted *object*; (b) finding a plurality of points in the image [*of the object*] to generate a fuzzy subset and compute a fuzzy distance transform (FDT) of the fuzzy subset. . . ."

Consequently, the cited Borgefors' fuzzy border-based distance transform that considers fuzziness at the time of initialization of a binary image, fails to teach, or even consider, each and every element of Applicants' claimed invention, which is specific to computation for an object or region-based fuzzy distance transform that advantageously considers fuzziness during iterative propagation. As a result, Borgefors' publication followed Applicants' date of invention, and thus is not a proper prior art reference to Applicants' invention; but even if it were, it fails to meet the §102(a) standard for anticipating Applicants' invention. Accordingly, Applicants respectfully ask that the rejection under 35 U.S.C. §102(a) be reconsidered and withdrawn.

Response to the Rejection under 35 U.S.C. §103(a).

The Examiner has rejected claims 2-5, 7, 10-11, 13 and 16 under 35 U.S.C. §103(a) as obvious over Borgefors *IEEE* (2002), in view of Wang, *IEEE*, pages 1114-1121 (1992). Recognizing the differences between Borgefors cited manuscript and Applicants' invention (no suggestion of "assigning to a point in the fuzzy subset to its respective fuzzy distance from a complement of a support of the fuzzy subset," which Applicants define as the FDT in claim 1, (and claims 2-5, 7, 10-11, 13 and 16 dependant thereon), see paragraph [0007]), to make this rejection the Examiner relies upon Wang to fill the gaps. The Examiner states that Wang teaches "assigning to a point in the fuzzy subset its respective fuzzy distance from a complement of a support of the fuzzy subset." See, page 1115, referring to a similarity of Borgefors "wherein the complement is the border and the medial axis transformation is the skeleton."

Applicants' traverse the Examiner's conclusion first because Wang teaches "binary" imaging – not the use of a fuzzy distance transform. Wang's Abstract begins by stating that " A generalized distance transformation (GDT) of *binary images* and the related medial axis transformation (MDT) are discussed." Yet nowhere in the cited Wang paper, is fuzzy distance transformation discussed or applied.

Applicants' claimed invention is specific to a "fuzzy distance transform-based computational method for analyzing digital images defining a volumetric region of an object from an image." This is neither taught nor suggested by a discussion of binary imaging. Applicants' have described the advantages of using a fuzzy distance transform over binary

imaging in the Background of the Invention section of their specification. The distance between two points is the Euclidian length (See specification at paragraph [0069] "Although only hard adjacency relations are considered to define a path, the Euclidean distance between two adjacent points should be used in a meaningful way in defining its length"). Using fuzzy distance transforms, a straight line is no longer considered to be the shortest distance between two points, which contradicts the old theories upon which support binary imaging, such as taught by Wang.

For example, at paragraph [0080] of the specification, Applicants' explain why binary imaging is inappropriate for the methods of the presently claimed invention:

> A basic reason behind this is the fact that in a binary image the shortest path from a point to the background (the complement of the binary object) is always a straight-line segment (in a digital sense). However, this is not true for fuzzy digital object (see FIG. 8). This makes a raster scan based approach *inappropriate in computing FDT*, as illustrated by example in FIG. 8.

Binary imaging is very limited in that it uses only 0 (background) and 1 (object), offering no possible way to account for the gradations in between. For that reason, fuzzy distance logic was developed and applied to the problems overcome in Applicants' claimed invention. Fuzzy distance accounts for all points. Consequently, the shortest path between 2 points may actually be convoluted, meaning that the length is fuzzy.

Consequently, when combined the cited Borgefors reference may well discuss a "fuzzy border distance transform" for use in the widely studied concept of skeletonization, it is based upon consideration of the fuzziness of a *binary image* at the time of initialization, and Wang also teaches *binary imaging*, albeit for an entirely different principle than the concepts which are essential to fuzzy distance logic. As a result even in combination, Borgefors and Wang utilize only *binary* imaging and fuzzy *border* distance transform methods. Together they fail to teach, or even consider, each and every element of Applicants' claimed invention, which is specific to computation for an object or region-based fuzzy distance transform, that advantageously considers fuzziness during iterative propagation. As a result, Borgefors' publication followed Applicants' date of invention, and thus is not a proper prior art reference to Applicants' invention; but even if it were and if it were combined with Wang, together they fails to meet the §103(a) standard for obviating Applicants' invention. Accordingly, Applicants respectfully ask that the rejection under 35 U.S.C. §103(a) be reconsidered and withdrawn, and Applicants' claims moved to allowance.

Response to the Second Rejection under 35 U.S.C. §103(a).

The Examiner has rejected claims 6, 8-9, 12 and 14-15 under 35 U.S.C. §103(a) as obvious over Borgefors *IEEE* (2002), in view of Wang, *IEEE*, pages 1114-1121 (1992), in further view of Saha *et al.*, *Comput. Vision Image Understanding* 77:145-174 (2000) of record. In making this rejection the Examiner states that the Saha 2000 reference fills the gap left by the combination of Borgefors and Wang with regard to Applicants' invention by disclosing "a fuzzy connectedness algorithm" (citing page 147), which is effective for biological target objects in MRI angiography, separation of bone and soft tissue from skin in CT imaging, etc, and when the image is obtained by magnetic resonance imaging or computed tomography. However, given that Dr. Saha and his colleagues are inventors of the present invention, they know full well their own prior disclosures and the needs that remained leading them to develop the improved methods for providing high resolution imaging that are claimed in the present invention, and as such Applicants traverse the Examiner's conclusion that the present invention is obvious over the cited combined references.

In light of the discussion in the foregoing section of the failure of Borgefors and Wang in combination to render Applicants' claimed invention obvious for those claims on which the presently rejected claims depend, the cited Saha 2000 reference must be examined to see what elements may be added to the previously combined references. Although Dr. Saha could provide yet another Declaration in this matter, explaining the elements that are different between his work in 2000, and the improved resolution that was made possible by the methods of the present invention, one needs only to turn to Applicants' specification, in which the inventors have explained the extent of his reliance on his prior work, particularly on the calculation of thickness (see paragraph [0118]), to permit the advancement of the science in the presently claimed methods. At paragraph [0125] Applicants expressly state that "segmentation may be improved by using more sophisticated methods (Udupa *et al.*, 1996; Saha *et al.*, 2000); however, segmentation is not a focus of the present invention." Nevertheless, in Experiments 2 and 3 of Example 3, Applicants' respective operations were performed on the raw micro-CT images first, and then the BVF computation method was applied.

In, for example, Experiment 2 at paragraph [0115] Applicants state that "the mask for the arterial tree was segmented from the rest of the tissue using scale-based fuzzy connectedness" (Saha *et al.*, 2000)." Improved methods of "segmentation" are not the subject of, nor are they

claimed in, Applicants' present invention, but paragraph [0115] continues to state that "A membership value μ_A(p) at each location within the segmented artery mask was computed" according to Equation 13. At paragraph [0116], "a zero membership value was assigned at each location outside the artery mask" and "the FDT image was computed for the 3D membership image of the arterial tree" as shown at FIG. 4(b) and 4(c). While "in order to compute thickness, a curve skeleton of the arterial tree was computed using the method in Saha *et al.*, 2000)," the step that is significant to the presently claimed method, involving using "a plurality of points in the image to generate a fuzzy subset and compute a FDT of the fuzzy subset" (see, claim 1), is missing from the Saha 2000 teaching. From the thickness values of the enhanced surface skeleton of the bone mask, Applicants then added the step of computing the FDT image, as claimed, based upon the resolution-enhanced BVF image. See Paragraph [0118].

Thus, while the earlier Saha work may have been the basis for enhancing the obtained image of the targeted object in claim 1, step (a), the presentation of the image regardless of the teachings of Saha 2000 remains limited to that one step. Saha 200 offers no step (b) or (c) in claim 1, wherein the method is defined as further "finding a plurality of points in the image to generate a fuzzy subset and compute a fuzzy distance transform (FDT) of the fuzzy subset," and "compiling a computer processed plot or revised image based upon the computed FDT."

As a result the distinctions between Applicants' claimed invention in claim 1, and the claims dependant thereon, and the combined Borgefors and Wang references, and that which cannot be taught by the Saha 2000 reference remain the same. Consequently, Borgefors' publication followed Applicants' date of invention, and thus is not a proper prior art reference to Applicants' invention; but even if it were and if it were combined with Wang and Saha 2000, the combined teaching still fails to teach steps (b) and (c) of Applicants' broadest claim 1, upon which all cited claims depend, regardless of whether Applicants' claimed method is applied to biological/medical target objects or not. Consequently, the combined references impermissibly fail to teach each and every element of Applicants' claimed invention, meaning that the combination fails to meet the §103(a) standard for obviating Applicants' invention. Accordingly, Applicants respectfully ask that the rejection of claims 6, 8-9, 12 and 14-15, which necessarily include all of the express elements of claim 1, under 35 U.S.C. §103(a) be reconsidered and withdrawn, and Applicants' claims moved to allowance.

<u>Response to the Third Rejection under 35 U.S.C. §103(a).</u>

The Examiner has rejected claims 17 and 22-25 under 35 U.S.C. §103(a) as obvious over Borgefors *IEEE* (2002), in view of Lang *et al.* (US 2003/0112921). In making this rejection the Examiner relies upon Borgefors for the above identified reasons in which the author teaches fuzzy border distance transforms to produce a skeletonized image. However, the Examiner acknowledges that Borgefors fails to teach that the object imaged by Borgefors is bone or that it is used for evaluating or diagnosing bone disease. However, by combining the Borgefors reference with Lang's teaching of x-ray imagines of bone to monitor the progression of bone disease, the Examiner has concluded that Applicants' invention would be obvious to one skilled in the art. Such a conclusion is, however, traversed by Applicants.

The Examiner fails to acknowledge the underlying differences between the Borgefors border-based transforms and Applicants' method defining analysis based upon the "*volumetric region* of an object." See claim 17. Thus, Borgefors' method and Applicants' are fundamentally different, meaning that the results are different, and cannot be readily compared. If the addition of Lang corrected that difference, the cited combination might be relevant to Applicants' invention. But it does not. Thus, the combined method of Lang and Borgefors cannot teach or suggest Applicants' method, since the principles for analyzing the image are different, and it most certainly cannot render Applicants' invention obvious

Radiographic scans, such as the X-ray scans used in the published Lang application measure bone or calcium density as compared with the density of air/gas, fat, or muscle, wherein density is defined as radiopaque to radiolucent. However, X-rays alone fail to provide the images needed in the present invention in that Lang offers no means for converting the x-rays into electronic impulses that produce readings of the density of the tissue in a slices, wherein the image is computer assembled, *e.g.*, in a CT scan or MR imaging. Thus, the Lang X-ray methods, although used to evaluate bone disease are inadequate, fail to suggest Applicants' invention. Methods, such as those taught by Lang, provide such low resolution images to the clinician that the need for improvement was recognized by Applicants and led them to conceive of the present invention, whereby fuzzy distance transform-based computational method was developed "for analyzing digital images defining a volumetric region of an object from an image" and providing computer processes plots and revised high resolution images. Thus, Applicants' invention was

designed to improve upon the methods of the prior art such as Lang's and could not have been obvious over such prior art.

Consequently, Borgefors' publication followed Applicants' date of invention, and thus is not a proper prior art reference to Applicants' invention; but even if it were and if it were combined with Lang, the combined teaching still fails to teach steps (b) and (c) of Applicants' independent claim 17, upon which cited claims 22-25 depend. As a result, the combined references impermissibly fail to teach each and every element of Applicants' claimed invention, meaning that the combination fails to meet the §103(a) standard for obviating claims 17 and 22-25 of Applicants' invention. Accordingly, Applicants respectfully ask that the rejection of claims 17 and 22-25 under 35 U.S.C. §103(a) be reconsidered and withdrawn, and Applicants' claims moved to allowance.

Regarding the Gomberg Doctoral Dissertation

On page 2 of the Detailed Action, the Examiner states that the 1.131 Gomberg Declaration of record was insufficient to overcome the 2002 Gomberg Doctoral Dissertation Thesis. However, no rejection was made or maintained in the present Action over the Gomberg Dissertation. Nevertheless to provide closure on this issue, Applicants have all three now signed a similar Declaration, attached hereto, entitled Declaration of Bryon Gomberg and Inventors under 37 C.F.R. §1.131. This should moot any standing or further rejection of the present invention over the Gomberg Dissertation, and Applicants ask that any remaining rejection relating thereto be removed.

In conclusion, Applicants assert that all pending claims are in condition for allowance, and Applicants earnestly solicit a Notice of Allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is

invited to telephone the undersigned at the number provided. If there are any fees due in connection with the filing of this response, please charge the fees to Deposit Account No. 50-4764.

Respectfully submitted,

Evelyn H. McConathy

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Evelyn H. McConathy
Registration No. 35,279
MONTGOMERY, McCRACKEN,
WALKER & RHOADS, LLP
123 South Broad Street
Philadelphia, PA 19109-1099
Tel: (215) 772.7550
Fax: (215) 772.7620

Encl: Declaration of Bryon Gomberg and Inventors under 37 C.F.R. §1.131